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(54) **STORAGE CONTROL DEVICE, ELECTRONIC APPARATUS, STORAGE MEDIUM, AND STORAGE CONTROL METHOD**

(71) Applicant: **KYOCERA DOCUMENT SOLUTIONS INC.**, Osaka (JP)

(72) Inventor: **Koji Fujii**, Osaka (JP)

(73) Assignee: **KYOCERA Document Solutions Inc.**, Osaka (JP)

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G06F 5/06 (2006.01)
G06F 3/06 (2006.01)

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CPC .. ***G06F 5/06*** (2013.01); ***G06F 3/06*** (2013.01); *G06F 3/067* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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An Office Action; "Notice of Reasons for Rejection," issued by the Japanese Patent Office on Apr. 14, 2015, which corresponds to Japanese Patent Application No. 2013-016395 and is related to U.S. Appl. No. 14/170,278.

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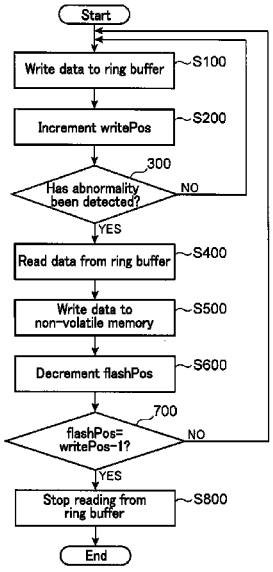
Primary Examiner — Brian Peugh
(74) *Attorney, Agent, or Firm* — Studebaker & Brackett PC

(57) **ABSTRACT**

A storage control device includes a first storage unit, a write control unit, and a read control unit. The first storage unit includes a plurality of storage areas corresponding to a plurality of addresses. The write control unit performs a write process to sequentially designate one of the plurality of addresses and write data to the storage area corresponding to the designated address, in a predetermined first order. The read control unit performs a read process to sequentially designate one of the plurality of addresses and read data stored in the storage area corresponding to the designated address, in a second order opposite to the first order, starting with the address corresponding to the storage area in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing.

8 Claims, 5 Drawing Sheets



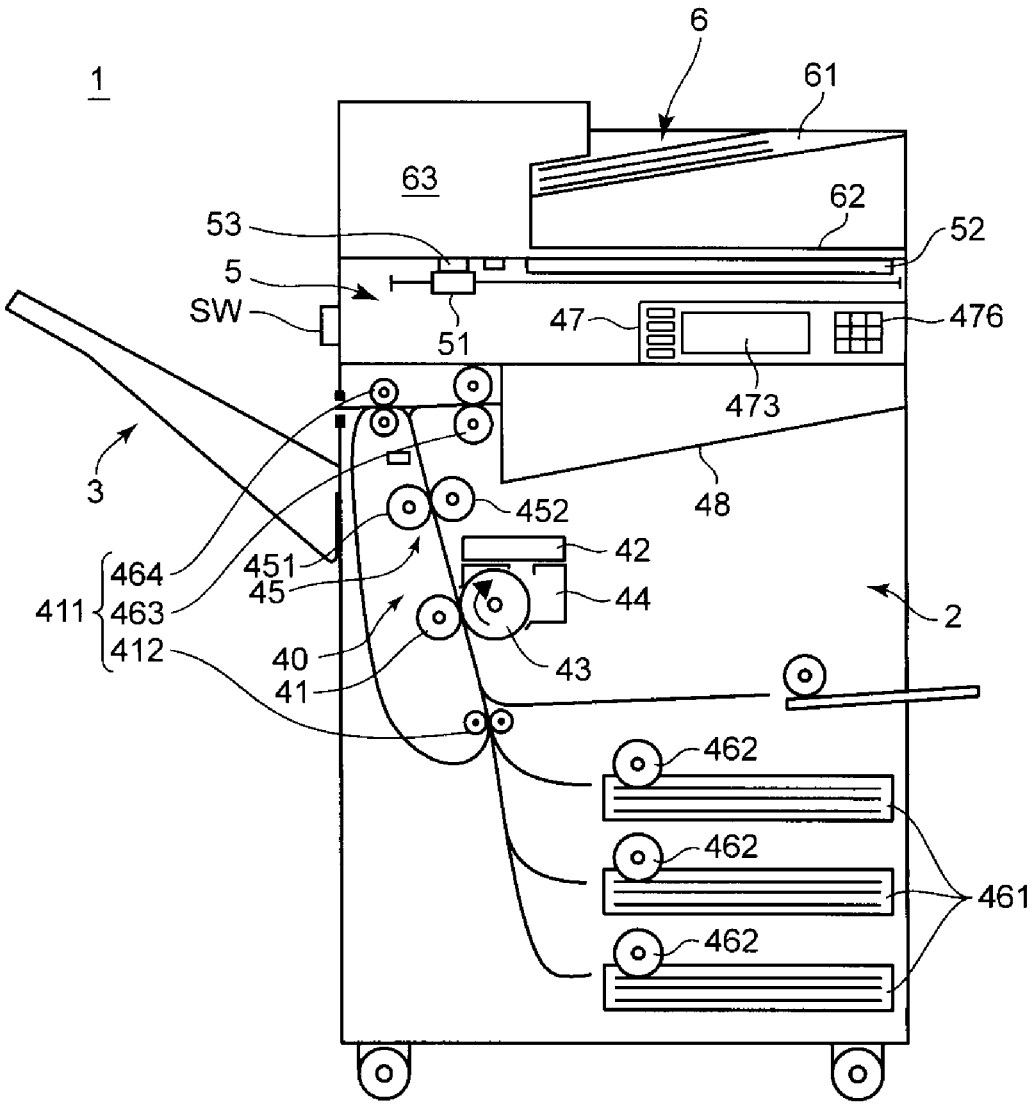

1
6
61
63
62
53
52
5
SW
51
47
476
473
3
48
452
42
464
451
45
411
463
44
2
412
40
43
41
462
462
461
462

FIG. 1

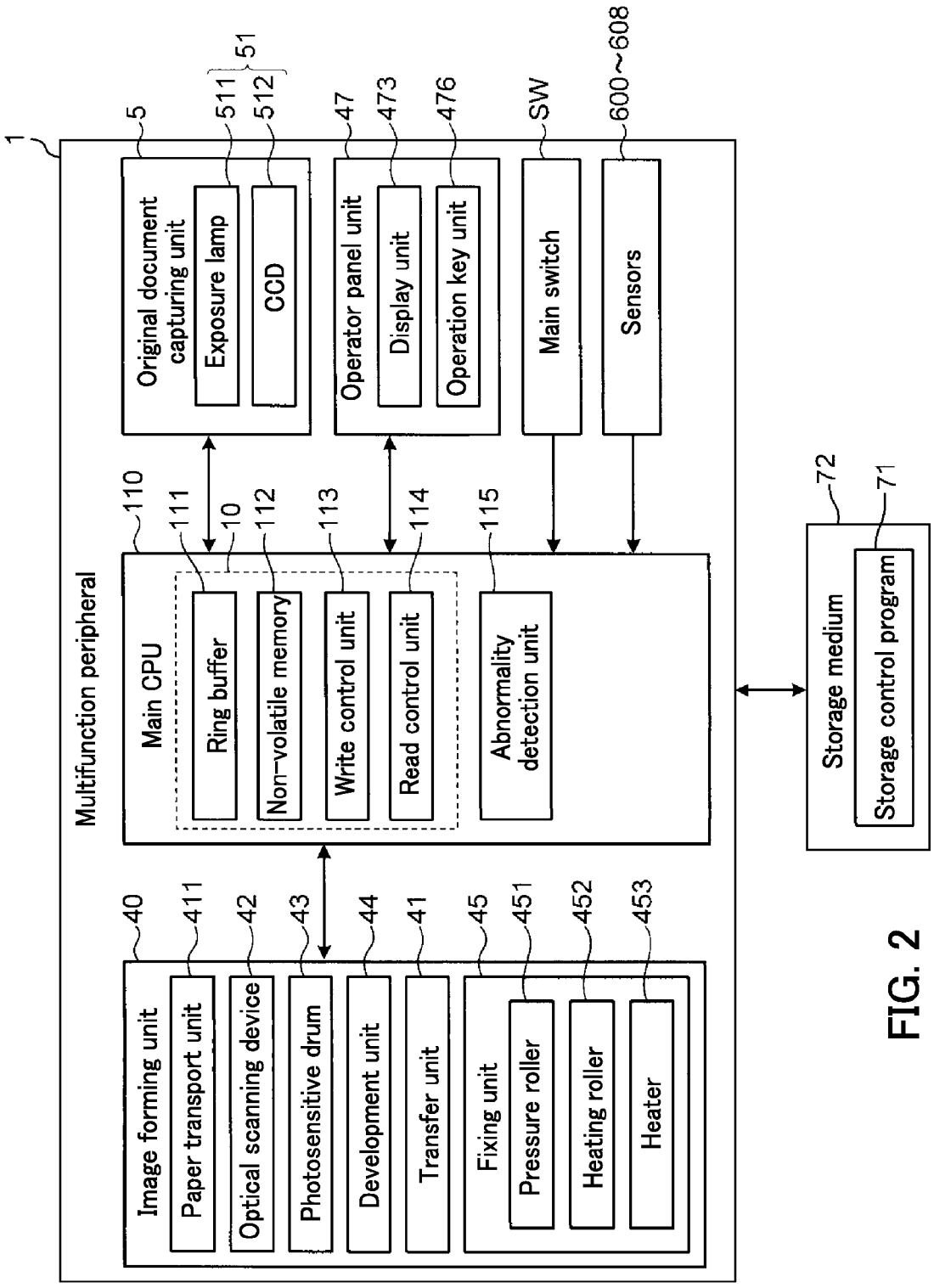

1
Multifunction peripheral
5
Original document capturing unit
Exposure lamp
CCD
511
512
51
47
Operator panel unit
Display unit
Operation key unit
473
476
SW
Main switch
600~608
Sensors
110
Main CPU
111
Ring buffer
10
112
Non-volatile memory
113
Write control unit
114
Read control unit
115
Abnormality detection unit
40
Image forming unit
411
Paper transport unit
42
Optical scanning device
43
Photosensitive drum
44
Development unit
41
Transfer unit
45
Fixing unit
451
Pressure roller
452
Heating roller
453
Heater
72
Storage medium
71
Storage control program

FIG. 2

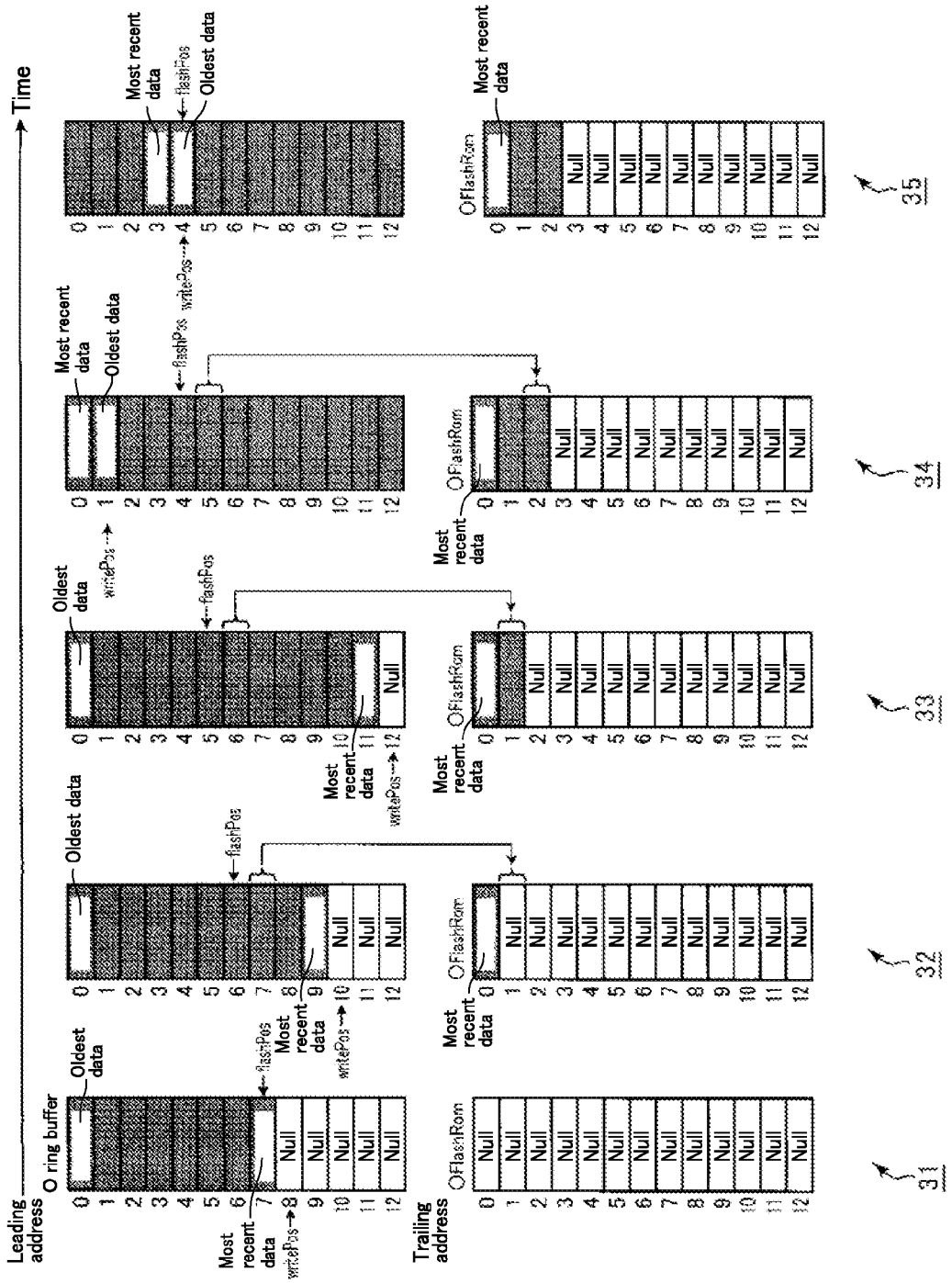

Time
Leading address
Trailing address
O ring buffer
OFlashRom
Oldest data
Most recent data
flashPos
writePos
Null
31
32
33
34
35

FIG. 3

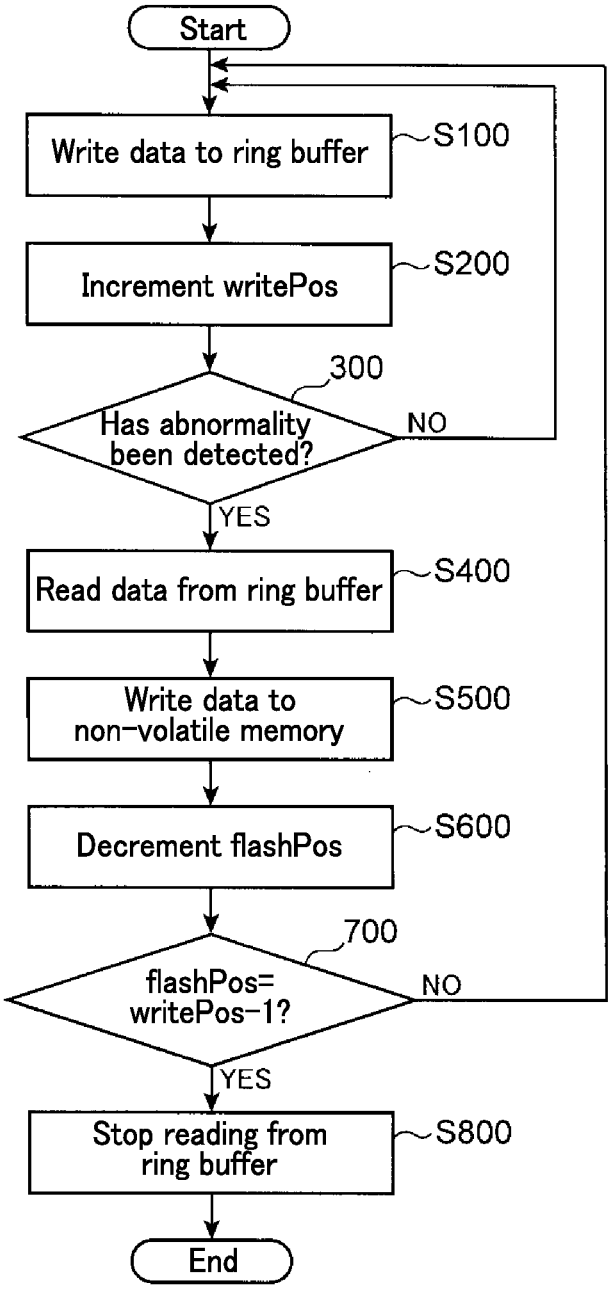

Start
Write data to ring buffer
S100
Increment writePos
S200
300
Has abnormality been detected?
NO
YES
Read data from ring buffer
S400
Write data to non-volatile memory
S500
Decrement flashPos
S600
700
flashPos= writePos-1?
NO
YES
Stop reading from ring buffer
S800
End

FIG. 4

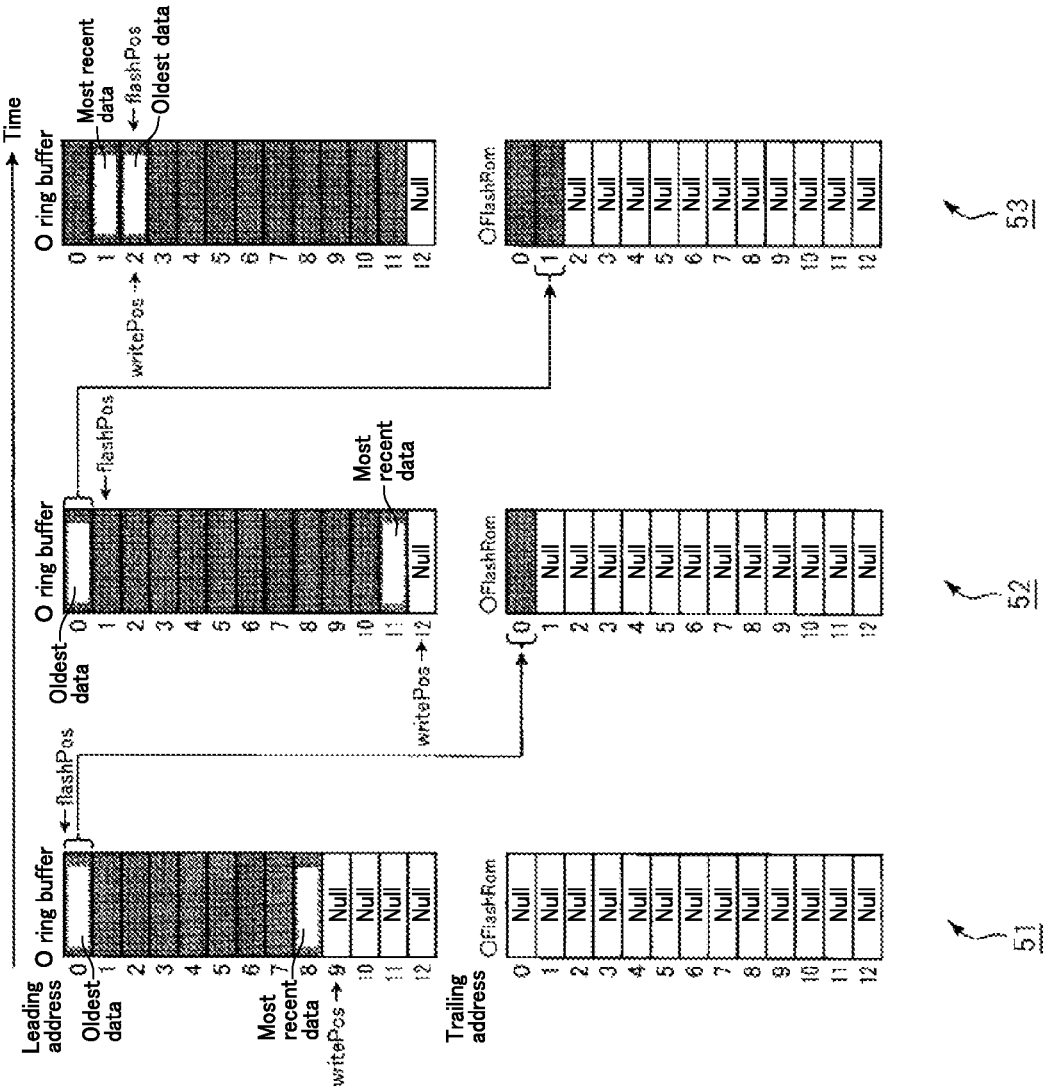

Time
Leading address
Trailing address
O ring buffer
OFlashRom
Oldest data
Most recent data
writePos
flashPos
Null
51
52
53

FIG. 5

STORAGE CONTROL DEVICE, ELECTRONIC APPARATUS, STORAGE MEDIUM, AND STORAGE CONTROL METHOD

INCORPORATION BY REFERENCE

The present application claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2013-016395, filed Jan. 31, 2013. The contents of this application are incorporated herein by reference in their entirety.

BACKGROUND

The present disclosure relates to storage control devices, electronic apparatuses, storage media, and storage control methods.

In recent electronic apparatuses, such as image forming apparatuses, information processing apparatuses, etc., logging is performed to record, to an area (log area) for storing log information in a random access memory (RAM), information about an operation or state of each functional part included in the apparatus, information indicating the detected value of a sensor included in the apparatus, etc. The term "log" refers to data indicating the history of an operation, state, etc. of a computer or each functional part, i.e., a set of pieces of information (data) related to an operation, state, etc. of a computer or each functional part, which are obtained over time. The term "logging" refers to recording of data to the log area. If such a log is saved, then when a problem or an abnormality occurs in an operation of the apparatus, the log can help a maintenance person to find out a cause for the problem or the abnormality. For example, the maintenance person can find out a cause or background for the problem by analyzing the log which has been recorded before the occurrence of the problem. The log may contain the detected value of a sensor or information about an abnormality in addition to the history.

The memory for saving the log may be configured so that data is written thereto in time series and data stored before the current write time is overwritten. The reason is as follows. Logging is, for example, performed in order to find out a cause for a problem, if any. Therefore, data contained in the log does not have to be permanently stored, and may be stored for a predetermined period of time. Therefore, after the predetermined period of time has passed, data contained in the log may be erased or old data may be overwritten with new data. This may allow the size of the log area to fall within a predetermined value. The memory for saving the log may be, for example, a ring buffer.

A ring buffer is a buffer having a conceptually ring-like structure, that has a storage area which is logically connected end-to-end. Specifically, in a ring buffer, assuming that the leading and trailing ends of the storage area are indicated by addresses A and B, respectively, when the write or read address for the storage area reaches the address B, the next address is the address A. If the storage area is written or read backward, then when the write or read address for the storage area reaches the address A, the next address is the trailing address B.

For example, when a user programmable read only memory (ROM) in which data is erased only in sectors is used as a ring buffer, there is a known technique of erasing data while using sectors efficiently.

SUMMARY

A storage control device according to an aspect of the present disclosure includes a first storage unit, a write control unit, and a read control unit. The first storage unit includes a plurality of storage areas corresponding to a plurality of addresses. The write control unit performs a write process to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged. The read control unit performs a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing.

An electronic apparatus according to another aspect of the present disclosure includes a storage control device, and an operation unit configured to perform an operation. The storage control device includes a first storage unit, a write control unit, and a read control unit. The first storage unit includes a plurality of storage areas corresponding to a plurality of addresses. The write control unit performs a write process to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged. The read control unit performs a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing. Data stored in the plurality of storage areas of the first storage unit is operation data related to the operation of the operation unit. In the write process, the write control unit sequentially stores the operation data to the first storage unit in time series, to store history information about the operation of the operation unit to the first storage unit.

A storage medium according to still another aspect of the present disclosure is a non-transitory computer readable storage medium having stored thereon a storage control program that, when executed by a computer including a first storage unit having a plurality of storage areas corresponding to a plurality of addresses, causes the computer to perform an information process. The information process includes performing a write process to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged, and performing a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing.

A storage control method according to still another aspect of the present disclosure is a method performed by a storage control device including a first storage unit having a plurality of storage areas corresponding to a plurality of addresses. The storage control method includes performing a write process

to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged, and performing a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing a structure of an example multifunction peripheral as an example electronic apparatus according to an embodiment of the present disclosure.

FIG. **2** is a block diagram showing an example internal configuration of the multifunction peripheral of FIG. **1**.

FIG. **3** is a diagram for describing a write process and a read process on a ring buffer and a write operation to a non-volatile memory according to an embodiment of the present disclosure.

FIG. **4** is a flowchart of a process performed by the multifunction peripheral according to an embodiment of the present disclosure.

FIG. **5** is a diagram for describing a write process and a read process on a ring buffer and a write operation to a non-volatile memory according to the conventional art.

DETAILED DESCRIPTION

An embodiment of the present disclosure will now be described with reference to the accompanying drawings. Note that the same reference characters designate the same or corresponding parts throughout the several views, and will not be redundantly described unless necessary to describe differences, i.e., differences among these parts will be mainly described.

FIG. **1** is a diagram showing a structure of an example electronic apparatus according to an embodiment of the present disclosure. In this embodiment, the electronic apparatus is a multifunction peripheral **1**. The multifunction peripheral **1** includes a storage control device **10** according to an embodiment of the present disclosure. The multifunction peripheral **1** is an image forming apparatus into which the functionality of a scanner, a copier, a printer, a facsimile machine, and the like is incorporated. Note that the electronic apparatus is not limited to the multifunction peripheral **1**, and may be a copier, a printer, a facsimile machine, or the like. The electronic apparatus may also be a smartphone, a tablet PC, or the like.

The multifunction peripheral **1** includes a body **2**, a stack tray **3**, an original document capturing unit **5**, and an original document feeder **6**. The stack tray **3** is provided on the left of the body **2**. The original document capturing unit **5** is, for example, provided in an upper portion of the body **2**. The original document feeder **6** is, for example, provided above the original document capturing unit **5**.

An operator panel unit **47** is provided on a front portion of the multifunction peripheral **1**. The operator panel unit **47** has, for example, a generally rectangular shape corresponding to a shape of the front portion. The operator panel unit **47** includes a display unit **473** and an operation key unit **476**. The display unit **473** is, for example, a liquid crystal display which also has the functionality of a touchscreen. The operation key unit **476** includes, for example, various key switches. The key switches are a start key which is used by the user to input a command for image formation, a numeric keypad which is used by the user to input the number of copies, etc.

The original document capturing unit **5** includes a scanner unit **51**, an original document stage **52** formed from a transparent member such as glass or the like, and an original document capturing slit **53**. The scanner unit **51** includes a charge coupled device (CCD) **512** and an exposure lamp **511** (see FIG. **2**). The scanner unit **51** is movable by means of a drive unit (not shown). For example, when an original document placed on the original document stage **52** is captured, the scanner unit **51** is moved along a surface of the original document, facing the original document stage **52**. The scanner unit **51** outputs, to a main CPU **110**, image data which is obtained while scanning an image on the original document. For example, when an original document fed by the original document feeder **6** is captured, the scanner unit **51** is moved to a position where the scanner unit **51** faces the original document capturing slit **53**. Thereafter, the scanner unit **51** obtains an image of the original document through the original document capturing slit **53** in synchronization with transportation of the original document performed by the original document feeder **6**. Thereafter, the scanner unit **51** outputs the obtained image data to the main CPU **110**. Note that, for example, a sensor **600** (see FIG. **2**) for detecting a jam of an original document is attached to the original document capturing slit **53**.

A main switch SW which turns on (supplies power) or off (stops power supply) a power supply to, for example, the entire apparatus is provided in a side portion of the original document capturing unit **5**. The main switch SW is, for example, a rocker switch. Note that the main switch SW is not necessarily needed. Power may be supplied to the entire apparatus by connecting the multifunction peripheral **1** to the commercial power supply.

The original document feeder **6** includes an original document loading tray unit **61** for placing original documents, an original document output tray unit **62** for outputting original documents from which images have been captured, and an original document transport mechanism **63**. The original document transport mechanism **63** picks up original documents placed on the original document loading tray unit **61**, one sheet at a time, transports the original document to a position which faces the original document capturing slit **53**, and outputs the original document to the original document output tray unit **62**. Note that, for example, a sensor **601** (see FIG. **2**) for detecting a jam or multi-feed (picking multiple sheets) of original documents is attached to the original document output tray unit **62**, the original document transport mechanism **63**, etc.

The body **2** includes a plurality of paper feed cassettes **461**, feed rollers **462**, and an image forming unit (an example operation unit) **40**. The feed roller **462** picks up paper from the paper feed cassette **461**, one sheet at a time, and transports the paper to the image forming unit **40**. The image forming unit **40** forms an image on the paper transported from the paper feed cassette **461**. Note that, for example, a sensor **602** (see FIG. **2**) for detecting a paper jam or a multi-feed is attached around the paper feed cassette **461**, the feed roller **462**, etc.

The image forming unit **40** includes a paper transport unit **411**, an optical scanning device **42**, a photosensitive drum **43**, a development unit **44**, a transfer unit **41**, and a fixing unit **45**.

The paper transport unit **411** is provided in a paper transport path in the image forming unit **40**. The paper transport unit **411** includes transfer rollers **412**, **463**, **464**, etc. The

transfer roller **412** feeds paper transported by the feed roller **462** to the photosensitive drum **43**. The transfer rollers **463** and **464** transport paper to the stack tray **3** or an output tray **48**. Note that, for example, a sensor **603** (see FIG. **2**) for detecting a jam or multi-feed of paper is attached around the paper transport unit **411** etc.

The optical scanning device **42** emits laser light or the like based on image data output from the main CPU **110** to expose the photosensitive drum **43** with the light, thereby forming an electrostatic latent image on the photosensitive drum **43**. The development unit **44** develops the electrostatic latent image on the photosensitive drum **43** with toner to form a toner image. The transfer unit **41** transfers the toner image from the photosensitive drum **43** to paper. Note that, for example, a sensor **604** (see FIG. **2**) for detecting a voltage (exposure voltage) applied during exposure is attached to the optical scanning device **42**. For example, a sensor **605** (see FIG. **2**) for detecting an electrostatic voltage applied during development of an electrostatic latent image is attached to the development unit **44**. For example, a sensor **606** (see FIG. **2**) for detecting a voltage (pressure voltage) of the pressure unit or pressure applied during transfer of a toner image is attached to the transfer unit **41**.

The fixing unit **45** heats paper with the transferred toner image to fix the toner image to the paper. The fixing unit **45** includes a heating roller **452** for melting a toner image formed on paper, and a pressure roller **451** for transporting paper while applying pressure to the paper between itself and the heating roller **452**. For example, a sensor **607** (see FIG. **2**) for detecting the temperature (fixing temperature) of the heating roller **452** for melting a toner image or the heater **453** (see FIG. **2**), and a sensor **608** (see FIG. **2**) for detecting the pressure value of the pressure roller **451**, are attached to the fixing unit **45**.

FIG. **2** is a block diagram showing an example internal configuration of the multifunction peripheral **1** of FIG. **1**. Additional elements shown in FIG. **2** will be mainly described with reference to FIG. **2**.

The fixing unit **45** includes the pressure roller **451**, the heating roller **452**, and a heater **453**. The heater **453** is, for example, provided inside the heating roller **452**. The heater **453** heats paper nipped between the heating roller **452** and the pressure roller **451** by heating the heating roller **452**.

The main CPU **110** controls the entire apparatus. During the beginning of power supply to the main CPU **110**, the main CPU **110** outputs a system reset signal to reset systems of parts included in the apparatus. The main CPU **110** performs operations of a ring buffer **111**, a non-volatile memory **112**, a write control unit **113**, a read control unit **114**, and an abnormality detection unit **115**. Note that the ring buffer **111**, the non-volatile memory **112**, the write control unit **113**, and the read control unit **114** constitute the storage control device **10**. In this embodiment, the write control unit **113** and the read control unit **114** are each implemented by the main CPU **110** executing a storage control program **71** which is software for a write process or a read process. The storage control program **71** may be previously installed in the multifunction peripheral **1**, or alternatively, as shown in FIG. **2**, installed into the multifunction peripheral **1** via a storage medium **72** storing the storage control program **71**. The storage medium **72** is, for example, a CD-ROM, a digital versatile disc (DVD), a hard disk, or a non-volatile memory. The storage control program **71** may be read out via a drive device compatible with the storage medium **72** to be installed into the multifunction peripheral **1**. Alternatively, the storage medium **72** storing the storage control program **71** may be included in a server connected to a communication network, and the multifunction peripheral **1** may access the server via the communication network to download the storage control program **71** from the storage medium **72** of the server. The write control unit **113** and the read control unit **114** may be implemented by hardware.

The ring buffer **111** is an example first storage unit. In the first storage unit, data in a storage area thereof may be overwritten with another new data. The ring buffer **111** is a memory which includes a plurality of storage areas corresponding to a plurality of addresses. The ring buffer **111** stores a log which is the history of an operation, state, etc. of the main CPU **110** or each functional part, i.e., a set of pieces of information (data) indicating an operation, state, etc. of the main CPU **110** or each functional part. Here, the functional parts are the original document capturing unit **5**, the image forming unit **40**, the fixing unit **45**, the operator panel unit **47**, etc. The storage area of the ring buffer **111** may be assigned to a storage area of a RAM.

The log saved in the ring buffer **111** helps a maintenance person to find out or analyze the operation, state, etc. of the CPU **110** or each functional part in an a posteriori manner. For example, when an abnormality occurs in the operation of the apparatus, the maintenance person may find out a cause for the abnormality by analyzing the log. In other words, for example, the maintenance person may find out a cause or background for the occurrence of a problem by analyzing the log which has been recorded before the occurrence of the problem. In the ring buffer **111**, a storage area corresponding to an address at which a write operation is currently performed stores most recent data. The main CPU **110** can access storage areas which store older data, in the backward direction, using addresses preceding the address of the storage area storing the most recent data. For example, when an abnormality occurs, data which was written immediately near the time of occurrence of the abnormality seems to be most related to the abnormality and have a highest degree of importance. Also, a storage area having an address which is closer to the address of the storage area storing the data which was written immediately near the time of occurrence of the abnormality, seems to be more related to the abnormality and have a higher degree of importance.

Data stored as a log is information about an operation of each functional part (operation unit). The functional parts are the image forming unit **40**, the transfer unit **41**, the development unit **44**, the fixing unit **45**, the original document capturing unit **5**, the original document feeder **6**, the operator panel unit **47**, the paper feed cassette **461**, the feed roller **462**, an intermediate transfer belt, etc. Examples of data stored as a log include information about operations or states of the functional parts, detected values of sensors, such as a temperature sensor etc., provided to the functional parts, abnormalities occurring in the sensors and the functional parts, etc. Although, in this embodiment, an intermediate transfer belt is not used, the multifunction peripheral **1** may include an intermediate transfer belt. Specifically, the multifunction peripheral **1** may transfer a toner image formed on the photosensitive drum to the intermediate transfer belt, and then transfer the toner image from the intermediate transfer belt to paper. In the description that follows, a case where an intermediate transfer belt is used is encompassed.

Examples of the operations of the functional parts include exposure by the optical scanning device **42**, development of an electrostatic latent image by the development unit **44**, application of pressure for transferring a toner image by the transfer unit **41**, melting of a toner image by the fixing unit **45**, etc.

Examples of the states of the functional parts include bit information stored in a status register of an LSI etc. used in each functional part, the temperature of a CCD included in the scanner unit **51**, the temperature of a laser included in the optical scanning device **42**, the potential of the photosensitive drum **43** in the development unit **44**, a transfer voltage in the transfer unit **41**, the temperatures of the heating roller **452** and the heater **453** in the fixing unit **45**, the amount of remaining toner, the amount of remaining paper, the presence or absence of an original document left on the original document stage **52**, etc.

Examples of the detected values of the sensors include the value of an exposure voltage in the optical scanning device **42**, the value of an electrostatic voltage in the development unit **44**, the value of a transfer voltage in the transfer unit **41**, the value of a fixing temperature in the fixing unit **45**, etc.

Examples of the abnormalities occurring in the functional parts include abnormalities due to a jam or multi-feed of original documents, abnormalities due to a jam or multi-feed of paper, an abnormal exposure voltage value in the optical scanning device **42**, an abnormal electrostatic voltage value in the development unit **44**, an abnormal transfer voltage value in the transfer unit **41**, an abnormal fixing temperature value in the fixing unit **45**, meandering of the intermediate transfer belt, a failure in a switch, lack of toner, etc.

Note that the abnormality detection (detection of the occurrence of an abnormality) is performed by the abnormality detection unit **115** as follows. The abnormality detection unit **115** detects an abnormality, for example, if the detected value of a temperature sensor is not within a predetermined range. The abnormality detection unit **115** detects an abnormality, for example, if a voltage value is not within a predetermined range. The abnormality detection unit **115** detects an abnormality, for example, if a temperature value is higher or lower than a predetermined value range. The abnormality detection unit **115** detects an abnormality which is meandering of the intermediate transfer belt, for example, if the detected value of a tension sensor for detecting the tension of the belt is not within a predetermined value range. The abnormality detection unit **115** detects an abnormality which is a failure in a switch, for example, if chattering is detected or there has been no input over a predetermined period of time. The abnormality detection unit **115** detects an abnormality which is lack of toner, for example, if a toner amount detection sensor detects lack of toner. The abnormality detection unit **115** detects an abnormality which is a jam or multi-feed of original documents or paper, for example, if a sensor detects the jam or multi-feed.

The non-volatile memory **112** is an example second storage unit. The non-volatile memory **112** is used to save a log read from the ring buffer **111**. For example, the non-volatile memory **112** stores data which had been recorded in the ring buffer **111** before the occurrence of an abnormality and was read from the ring buffer **111** on the occurrence of the abnormality, i.e., data contained in a log. The non-volatile memory **112** is, for example, a non-volatile storage device, such as a flash ROM, an electrically erasable programmable ROM (EEPROM), etc. The reason why a log is saved in the non-volatile memory **112** is that even if the power supply is turned off or interrupted, the log remains in the non-volatile memory **112**, and therefore, a maintenance person may find out a cause for an abnormality by reading and referencing the log. If an abnormality occurs, the power supply may be turned off or interrupted. Therefore, it is useful to save a log to the non-volatile memory **112**.

Note that the ring buffer **111** can be simultaneously written and read. Therefore, the main CPU **110** can simultaneously write both the non-volatile memory **112** and the ring buffer **111**. Specifically, the main CPU **110** can read data from the ring buffer **111** and then write the read data to the non-volatile memory **112** in parallel to a data write operation to the ring buffer **111**. With this configuration, even in case of emergency such as an abnormality etc., while the read control unit **114** reads important data from the ring buffer **111** and then writes the data to the non-volatile memory **112**, the write control unit **113** can write the operation log, state log, etc. of each functional part to the ring buffer **111** in parallel without interruption.

The write control unit **113** performs a write process. In the write process, the write control unit **113** sequentially designates addresses in a predetermined first order in which a plurality of addresses are arranged in the ring buffer **111**, and sequentially stores data to storage areas corresponding to the designated addresses. The first order may be any order in addition to the order (ascending order, descending order, etc.) of address. In this embodiment, the first order is an order of successive addresses of the ring buffer **111** which are provided at predetermined positions in a RAM, starting with the leading address toward the trailing address. An address at which a write operation is performed first is, for example, the leading address of the ring buffer **111**. In this embodiment, the write address is incremented.

Note that, in the write process to the ring buffer **111**, after storing data to a storage area corresponding to the last address in the first order, the write control unit **113** next sequentially designates addresses from the first address in the first order to continue the write process. In other words, in the write process, when the last address in the first order (in this embodiment, the trailing address of the ring buffer **111**) is reached, the first address in the first order (in this embodiment, the leading address of the ring buffer **111**) is designated as the next address.

The read control unit **114** performs a read process. In the read process, the read control unit **114** sequentially designates addresses in a second order which is the opposite order to the first order, from a predetermined start timing after the execution of the write process, starting with an address corresponding to a storage area in which data has been stored immediately near the predetermined start timing, to sequentially read, from the ring buffer **111**, data stored in storage areas corresponding to the designated addresses. The second order is the opposite order to the first order. Therefore, in this embodiment, the read process is performed in a direction of successive order from the trailing address to the leading address of the ring buffer. The read process may be started from any address. In this embodiment, the start address is an address at which the write control unit **113** has performed a write operation on or immediately before the occurrence of an abnormality in a functional part, in order to save a log when an abnormality occurs. This is because a storage area corresponding to an address which is closer to the address of the storage area at which the write control unit **113** has performed a write operation on or immediately before the occurrence of an abnormality, seems to store data which is more related to the abnormality and has a higher degree of importance. In other words, the predetermined start timing in this embodiment is when an abnormality occurs in a functional part, or specifically, when the abnormality detection unit **115** detects an abnormality in a functional part. Note that, in this embodiment, the read address is decremented.

The read control unit **114** also stores data read by the read process to the non-volatile memory **112**.

In this embodiment, the main CPU **110** sequentially reads data in the opposite order to the order in which data was

stored, immediately after a time when an abnormality occurs, and saves the data to the non-volatile memory **112**. Therefore, even when the reading speed is lower than the writing speed, a log having a high degree of importance and a high degree of necessity, that has been recorded before the occurrence of a problem, can be saved to the non-volatile memory **112** before being overwritten.

Note that after reading data from the ring buffer **111** with the last address in the second order being designated, the read control unit **114** next sequentially designates addresses, starting with the first address in the second order, to perform the read process. In other words, in the read process, when the last address in the second order (in this embodiment, the leading address of the ring buffer **111**) is reached, the first address in the second order (in this embodiment, the trailing address of the ring buffer **111**) is designated as the next address.

The reason why the read process is performed in such a manner is as follows. In general, the data writing speed to the non-volatile memory **112** is lower than the data writing speed to and the data reading speed from the ring buffer **111** (RAM). Therefore, when data is read from the ring buffer **111** and then written to the non-volatile memory **112**, the data reading speed from the ring buffer **111** is limited by the data writing speed to the non-volatile memory **112**. Therefore, the data reading speed from the ring buffer **111** is lower than the data writing speed to the ring buffer **111**. Therefore, when the non-volatile memory **112** and the ring buffer **111** are used in combination, a log which is needed may be unfortunately overwritten with new data before being read from the ring buffer **111**. In a log, old data may be overwritten with new data after a predetermined period of time (for example, a period of time which is long enough to produce history which enables a maintenance person to find out, analyze, etc. an abnormality) has passed. However, a log is saved in order to help a maintenance person to, for example, find out a cause for the occurrence of a problem, if any, and therefore, if a log having a high degree of importance and a high degree of necessity, that has been recorded before the occurrence of a problem, is overwritten with new data and therefore eliminated before being read out, a maintenance person cannot successfully find out a cause for the occurrence of a problem based on the log.

Note that, in order to address such a drawback, the following technique may be used, for example. Specifically, another memory (hereinafter also referred to as a "copy buffer") may be provided between the ring buffer **111** and the non-volatile memory **112**. A predetermined amount of log is periodically copied and the resultant copy is saved to the copy buffer. Thereafter, the data in the copy buffer is stored to the non-volatile memory **112**. In this case, however, the use of the copy buffer leads to problems, such as an increase in the number of parts, a more complicated configuration, an increase in cost, etc.

In the storage control device **10** of this embodiment, the order in which data is read from the ring buffer **111** is the second order which is opposite to the first order for the write process, and the read process begins at an address at which the write control unit **113** has performed a write operation on or immediately before detection of an abnormality in a functional part. Therefore, a log which has been recorded before the occurrence of an abnormality can be saved to the non-volatile memory **112** as soon as possible. Therefore, in this embodiment, the copy buffer between the ring buffer **111** and the non-volatile memory **112** is not needed.

As shown in FIG. **2**, the multifunction peripheral **1** of this embodiment includes the original document capturing unit **5**, the image forming unit **40**, the fixing unit **45**, and the operator panel unit **47**, which are operation units (functional parts) which perform respective predetermined operations. The write control unit **113** performs the write process to sequentially write information about operations, states, etc. of the functional parts in time series to the ring buffer **111** to produce a log.

The abnormality detection unit **115** detects an abnormality in each functional part. The abnormality detection unit **115** may detect an abnormality in each of the sensors **600-608** as an abnormality of a corresponding functional part. Abnormalities in the functional parts and a technique of detecting the abnormalities have been described above.

An operation of, when an abnormality occurs in a functional part, reading data contained in a log from the ring buffer **111** and storing the data to the non-volatile memory **112** (in FIG. **3**, a "flash ROM") will be described with reference to FIG. **3**. In FIG. **3**, the ring buffer **111** and the non-volatile memory **112** (flash ROM) are schematically arranged side by side in the vertical direction. The horizontal direction represents elapsed time. Specifically, FIG. **3** shows that the states of the ring buffer **111** and the non-volatile memory **112** change over time from a state **31** to a state **35**. The ring buffer **111** and the non-volatile memory **112** each include a plurality of storage areas (save areas) corresponding to a plurality of addresses. Note that address numbers 0-12 are sequentially assigned to the storage areas of each of the ring buffer **111** and the non-volatile memory **112**, starting with the uppermost storage area, for the sake of convenience. Although only 13 storage areas are shown for each of the ring buffer **111** and the non-volatile memory **112** because of space limitations, each of the ring buffer **111** and the non-volatile memory **112** may include any number of storage areas. The storage areas of the ring buffer **111** and the non-volatile memory **112** include hatched ones and non-hatched ones. The hatched areas indicate storage areas in which data has been written by the write control unit **113** or the read control unit **114**. The non-hatched areas indicate storage areas in which data has not been written.

A write pointer (in FIG. **3**, "writePos") indicates an address (the next address) immediately succeeding an address (write address) at which data has been written most recently. A read pointer (in FIG. **3**, "flashPos") indicates an address (the previous address) immediately preceding, in address order, an address (read address) at which data has been read most recently (the previous address is the next address in the second order).

In the ring buffer **111**, when most recent data is written to a storage area corresponding to an address indicated by the write pointer, the write control unit **113** increments the write pointer by one to move the write pointer to the next address. Thereafter, every time the write control unit **113** writes most recent data to the ring buffer **111**, the write control unit **113** increments the write pointer by one. Thereafter, when the write pointer reaches the trailing address of the ring buffer **111**, the write control unit **113** designates an address indicted by the write pointer and then writes most recent data to the ring buffer **111** at the designated address, and thereafter, sets the write pointer back to the leading address.

On the other hand, the ring buffer **111** is read as follows: the read control unit **114** performs the read process to read data from a storage area corresponding to an address indicated by the read pointer, and then writes the data to the non-volatile memory **112**; and thereafter, the read control unit **114** moves the read pointer to the next address. Note that the read pointer is moved in the opposite direction to the direction in which the write pointer is moved, i.e., the read pointer is decremented by one. Thereafter, every time the read control unit **114** reads

data from the ring buffer **111**, the read control unit **114** decrements the read pointer by one. When the read pointer reaches the leading address of the ring buffer **111**, the read control unit **114** reads data at an address indicated by the read pointer, and then moves the read pointer to the trailing address. Note that the read process is performed in parallel with the write process.

The state **31** of FIG. **3** indicates the states of the ring buffer **111** and the non-volatile memory **112** at a time when the abnormality detection unit **115** detects an abnormality. No data has been stored in the non-volatile memory **112**, i.e., the non-volatile memory **112** is empty. The write pointer has been set by the write control unit **113** to the next address (address 8) succeeding an address (address 7) corresponding to a storage area which stores most recent data which was obtained immediately near the time of occurrence of the abnormality. On the other hand, the read pointer has been set by the read control unit **114** to the address (address 7) corresponding to the storage area which stores most recent data which was obtained immediately near the time of occurrence of the abnormality.

The write process to the ring buffer **111** by the write control unit **113**, and the read process from the ring buffer **111** and the write process to the non-volatile memory **112** by the read control unit **114**, will now be described with reference to FIG. **3** and a flowchart shown in FIG. **4**.

When the write control unit **113** begins the write process to the ring buffer **111**, the write control unit **113** causes the process to proceed to step S**100**. In step S**100**, as a normal logging operation, the write control unit **113** designates an address using the pointer "writePos" and then performs the write process to write most recent data to the ring buffer **111**. Thereafter, the write control unit **113** causes the process to proceed to the next step S**200**.

In step S**200**, the write control unit **113** increments the pointer "writePos" by one, i.e., adds one to the pointer "writePos." Note that when this increment causes the position of the pointer "writePos" to move to the next address succeeding the trailing address (12) of the ring buffer **111**, the write control unit **113** sets the pointer "writePos" back to the leading address (0). Next, the write control unit **113** causes the process to proceed to step S**300**.

In step S**300**, it is determined whether or not the abnormality detection unit **115** has detected an abnormality in a functional part. If the result of the determination in step S**300** is positive ("YES"), the abnormality detection unit **115** causes the process to proceed to step S**400**. If the result of the determination in S**300** is negative ("NO"), the abnormality detection unit **115** causes the process to proceed to step S**100**. Note that, after an abnormality has been detected, the abnormality detection unit **115** continues to cause the process to proceed from step S**300** to step S**400**, without selecting the branch from step S**300** back to step S**100**.

In steps S**400**-S**700**, because the abnormality detection unit **115** has detected the occurrence of an abnormality (YES in step S**300**), the read control unit **114** reads data which has been stored on the occurrence of the abnormality and data which has been stored before the occurrence of the abnormality, from the ring buffer **111**, and then stores the data to the non-volatile memory **112**.

Steps S**400**-S**700** will now be described in detail. Note that data which has been stored on the occurrence of an abnormality means data which the write control unit **113** has written to the ring buffer **111** immediately near the occurrence of the abnormality. Therefore, in step S**300**, the read control unit **114** sets the pointer "flashPos" to the previous address preceding an address which is indicated by the pointer "writePos" which was set at the time when the abnormality detection unit **115** detected an abnormality (see the state **31** of FIG. **3**). After the detection of the abnormality, the read control unit **114** begins the read process to designate the address using the pointer "flashPos" and then read data from the ring buffer **111**.

In step S**400**, the read control unit **114** reads data from a storage area of the ring buffer **111** having the address indicated by the pointer "flashPos." Thereafter, the read control unit **114** causes the process to proceed to the next step S**500**.

In step S**500**, the read control unit **114** stores the data read from the ring buffer **111** to the non-volatile memory **112**. The read control unit **114** causes the process to proceed to the next step S**600**.

In step S**600**, the read control unit **114** decrements the pointer "flashPos" by one, i.e., subscribes one from the pointer "flashPos." Note that, if this decrement causes the pointer "flashPos" to move to the previous address preceding the leading address of the ring buffer **111**, the read control unit **114** sets the pointer "flashPos" back to the trailing address. The read control unit **114** causes the process to proceed to the next step S**700**.

As shown in FIG. **3**, as time passes, the write control unit **113** sequentially writes data to the ring buffer **111** while incrementing the write pointer by one at a time (steps S**100** and S**200**), to store a log in the ring buffer **111** (see the states **32** and **33** of FIG. **3**). On the other hand, the read control unit **114** sequentially reads data from the ring buffer **111** while decrementing the read pointer by one at a time (step S**400** and step S**600**) and then stores the read data to the non-volatile memory **112** (step S**500**). As a result, of the log, data which has been recorded immediately near the occurrence of an abnormality and data which has been recorded before the occurrence of the abnormality are stored in the non-volatile memory **112** (see the states **32** and **33** of FIG. **3**). Note that when the state **33** of FIG. **3** is changed to the state **34**, the write pointer reaches the trailing address (address 12) of the ring buffer **111**. At this time, the write control unit **113** sets the write pointer back to the leading address in order to write new most recent data.

While the state **31** of FIG. **3** is changed to the state **34**, six pieces of data are written to the ring buffer **111**. On the other hand, the non-volatile memory **112** stores three pieces of data which have been recorded before the occurrence of an abnormality. In other words, during this period of time, while the pointer "writePos" is moved forward by six, the pointer "flashPos" is moved backward only by three. Thus, the writing speed is about twice as high as the reading speed.

Referring back to FIG. **4**, in step S**700**, the main CPU **110** determines whether or not the value of "writePos−1" is equal to the value of "flashPos." If the pointer "writePos" and the pointer "flashPos" indicate the same storage area, then when the write control unit **113** writes most recent data to this storage area or the read control unit **114** reads data from this storage area, the relationship between the value of the pointer "writePos" and the value of the pointer "flashPos" becomes "flashPos=writePos−1." In this case, a log which should be stored to the non-volatile memory **112** is overwritten with most recent data and is thereby erased. Therefore, if "flashPos=writePos−1," the main CPU **110** determines to end saving of a log to the non-volatile memory **112** (YES in step S**700**). Thereafter, the main CPU **110** causes the process to proceed to step S**800**. Unless "flashPos=writePos−1" (NO in step S**700**), the main CPU **110** causes the process to proceed to step S**100**.

In the state **35** of FIG. **3**, the pointer "writePos" and the pointer "flashPos" indicate the same address (address 4). If

the pointer "writePos" and the pointer "flashPos" indicate the same address, then when the write control unit **113** writes most recent data to a storage area corresponding to that address or the read control unit **114** reads data from the storage area corresponding to that address, the relationship between the value of the pointer "writePos" and the value of the pointer "flashPos" becomes "flashPos=writePos−1." In this case, a log which should be stored to the non-volatile memory **112** is overwritten with most recent data and is thereby erased. Therefore, the read control unit **114** ends the read process from the ring buffer **111** and the write process to the non-volatile memory **112**. In other words, the log write operation to the non-volatile memory **112** is ended.

In step **S800** of FIG. **4**, the read control unit **114** ends the read process from the ring buffer **111** and the log save operation to the non-volatile memory **112**.

Next, a problem which occurs if the direction in which the read address is moved is the same as the direction in which the write address is moved, will be described with reference to FIG. **5**. Although an operation shown in FIG. **5** is different from the operation of the storage control device **10** of this embodiment, a part corresponding to the write control unit **113** is referred to as a write control unit, and a part corresponding to the read control unit **114** is referred to as a read control unit, for the sake of convenience. FIG. **5** is a diagram for describing the write and read processes on the ring buffer **111** and the write operation to the non-volatile memory **112** when the direction in which the read address is moved is the same as the direction in which the write address is moved. In FIG. **5**, the ring buffer **111** and the non-volatile memory **112** (flash ROM) are schematically arranged side by side in the vertical direction. The horizontal direction represents elapsed time. Specifically, FIG. **5** shows that the states of the ring buffer **111** and the non-volatile memory **112** change over time from a state **51** to a state **53**. The ring buffer **111** and the non-volatile memory **112** each include a plurality of storage areas (save areas) corresponding to a plurality of addresses. Address numbers 0-12 are sequentially assigned to the storage areas of each of the ring buffer **111** and the non-volatile memory **112**, starting with the uppermost storage area, for the sake of convenience.

The write control unit performs the write process to write most recent data to the ring buffer **111**. Therefore, after writing the most recent data, the write control unit increments the write pointer (in FIG. **5**, "writePos") by one to move the write pointer to the next address. On the other hand, the read control unit performs the read process from the ring buffer **111** in parallel. In this case, the read control unit performs the following operation according to a technique shown in FIG. **5**.

The read control unit reads, from the ring buffer **111**, data indicated by the read pointer (in FIG. **5**, "flashPos"). The read control unit writes the read data to the non-volatile memory **112** and increments the read pointer by one. Note that the direction in which the read pointer is moved is the same as the direction in which the write pointer is moved, and the read pointer is incremented by one. Thereafter, every time the read control unit reads data from the ring buffer **111**, the read control unit increments the read pointer by one. When the read pointer reaches the trailing address of the ring buffer **111**, the read control unit reads data at an address indicated by the read pointer, and then moves the read pointer to the leading address. Thus, in the technique of FIG. **5**, the read pointer is moved in a direction and manner similar to those of the write process.

In the state **51** of FIG. **5**, the write pointer is set to the next address (address 9) succeeding an address (address 8) at which most recent data is stored. On the other hand, no data has been stored in the non-volatile memory **112**, i.e., the non-volatile memory **112** is empty. The read pointer has been set to the address 0. Note that, in FIG. **5**, in order to describe the problem, it is assumed that the read pointer begins with the address 0, instead of beginning reading at the time when an abnormality occurs.

In the example of FIG. **5**, as time passes, the ring buffer **111** and the non-volatile memory **112** change from the state **51** to the state **53**. In the state **52** of FIG. **5**, the write pointer reaches the trailing address (address 12) of the ring buffer **111**. When new most recent data is written to the address 12, the write control unit sets the write pointer back to the leading address. Note that, during the time between the state **51** and the state **52**, the read control unit saves a piece of data to the non-volatile memory **112**, and the write control unit writes three pieces of data to the ring buffer **111**. Therefore, the writing speed is about triple as high as the reading speed.

In the state **53** of FIG. **5**, the pointer "writePos" and the pointer "flashPos" indicate the same address (address 2). If the pointer "writePos" and the pointer "flashPos" indicate the same address, then when the write control unit writes most recent data to a storage area corresponding to that address, a log which should be saved to the non-volatile memory **112** is overwritten with most recent data and is thereby erased. Therefore, the read control unit ends the read process from the ring buffer **111** and the write process to the non-volatile memory **112**. In other words, the log write operation to the non-volatile memory **112** is ended. Note that the read control unit may read data at that address before the write control unit writes most recent data. However, because the writing speed is higher than the reading speed, a case subsequently occurs where the write control unit writes most recent data to that address before the read control unit reads data from that address.

As described above, in the technique described with reference to FIG. **5**, the writing speed is higher than the reading speed. The direction in which the write pointer is moved is the same as the direction in which the read pointer is moved. Therefore, when data is read from the ring buffer **111** and then written to the non-volatile memory **112**, starting from the time of occurrence of an abnormality, the read control unit cannot write, to the non-volatile memory **112**, a sufficient amount of data which has been recorded before the occurrence of the abnormality, compared to this embodiment. The reason is as follows. The direction in which the write pointer is moved is the same as the direction in which the read pointer is moved. Therefore, in order to read data which has been recorded before the occurrence of the abnormality, an address at which the read pointer begins (read start timing) is set to any timing before the occurrence of the abnormality and then the read pointer is incremented. However, because the writing speed is higher than the reading speed, the write pointer subsequently overtakes the read pointer. In this case, data which has been recorded immediately near the time of occurrence of the abnormality is overwritten by the write process and is thereby erased, and therefore, cannot be written to the non-volatile memory **112**.

In the storage control device **10** and the multifunction peripheral **1** of this embodiment, the write control unit **113** performs the write process in the first order. The read control unit **114** performs the read process from the predetermined start timing after the beginning of execution of the write process, while sequentially designating addresses from an address corresponding to a storage area to which data has been stored immediately before the start timing, in the second direction opposite to the first order. As a result, for example, even when the reading speed is lower than the writing speed,

the read process is performed sequentially backward from the data which has been stored immediately before by the write control unit **113**. Therefore, the read control unit **114** can read the data which has been recorded immediately before and data preceding that data, i.e., data having a higher degree of importance, and save these pieces of data to the non-volatile memory **112** before these pieces of data are overwritten. In other words, when data which has been read from the ring buffer **111**, which has a higher access speed, is written to the non-volatile memory **112**, which has a lower access speed, the reading speed from the ring buffer **111** is limited by the writing speed to the non-volatile memory **112**. Therefore, the reading speed from the ring buffer **111** is lower than the writing speed. Even in such a case, the storage control device **10** and the multifunction peripheral **1** according to this embodiment can save a log which is needed, before the log is overwritten.

Note that this embodiment is not limited to the case where the read control unit **114** reads data from the ring buffer **111** and then stores the read data to the non-volatile memory **112**. For example, the multifunction peripheral **1** may include a communication circuit unit which can be connected to a communication line, such as a public network, a local area network (LAN), etc. The read control unit **114** may transmit data read from the ring buffer **111** to an external apparatus via the communication line. In this case, data read by the read control unit **114** is transmitted to a communication network etc. having a lower transfer speed, and therefore, the reading speed from the ring buffer **111** is limited by the lower transfer speed. Therefore, the reading speed from the ring buffer **111** is lower than the writing speed. Even in such a case, similar to the foregoing, a log which is needed can be saved before being overwritten.

The storage control device **10** and the multifunction peripheral **1** further include the non-volatile memory **112**, which is the non-volatile second storage unit. The read control unit **114** stores data read by the read process to the non-volatile memory **112**. Therefore, in addition to the foregoing advantage, even if the power supply to the multifunction peripheral **1** is interrupted, and therefore, data stored in the ring buffer **111**, which is the first storage unit, is erased, the data remains in the non-volatile memory **112**, and the read control unit **114** can read and reference the data.

The storage control device **10** and the multifunction peripheral **1** according to this embodiment can save a log which is needed, before the log is overwritten, by means of the above-described write and read processes, without providing an additional memory for buffering (copy buffer) between the ring buffer **111** and the non-volatile memory **112**. Therefore, problems, such as an increase in the number of parts, a more complicated configuration, an increase in cost, etc., due to the use of an additional memory can be avoided.

With this configuration, the multifunction peripheral **1** includes the storage control device **10** having the above advantages. Therefore, the write process is performed in the first order, and after the beginning of execution of the write process, the read process is performed in the second order opposite to the first order, starting with an address at which data has been written by the write control unit **113** immediately before. Data stored in a storage area corresponding to an address at which the read process has begun and data stored in a storage area corresponding to the previous address preceding that address have a high degree of importance. Therefore, if the read process is performed from the address at which data has been written by the write control unit **113** immediately before, sequentially in the opposite order to the order in which data has been written, the read control unit **114** can read data having a high degree of importance before the data is overwritten and erased in the ring buffer **111**. Therefore, in the multifunction peripheral **1**, even if the reading speed is lower than the writing speed, data having a high degree of importance stored in the ring buffer **111** can be read from the ring buffer **111** and then stored to the non-volatile memory **112** before the data is overwritten.

The multifunction peripheral **1** also includes the abnormality detection unit **115** for detecting an abnormality in the operation units. The start timing is, for example, when the abnormality detection unit **115** detects an abnormality in an operation unit. As a result, in addition to the above advantages, the multifunction peripheral **1** can read, from the ring buffer **111**, data which has been recorded before the occurrence of an abnormality in an operation unit. In order to remove an abnormality, data which has been recorded on and before the occurrence of the abnormality is important. By analyzing the data, a maintenance person may find out operations and states of the apparatus which occurred on and until the occurrence of the abnormality. Thus, if the start timing is set to a time when the abnormality detection unit **115** detects an abnormality in an operation unit, the read control unit **114** can read important data which has been recorded on and before the occurrence of an abnormality, and store the data to the non-volatile memory **112**.

The electronic apparatus is, for example, an image forming apparatus (the multifunction peripheral **1**) including an image forming unit for forming an image on paper. The multifunction peripheral **1** has the above advantages, and therefore, performs the write process in the first order, and after the beginning of execution of the write process, performs the read process in the second order opposite to the first order, starting with an address at which data has been written by the write control unit **113** immediately before. Data stored in a storage area corresponding to an address at which the read process has begun and data stored in a storage area corresponding to the previous address preceding that address have a high degree of importance. Therefore, if the read process is performed from the address at which data has been written by the write control unit **113** immediately before, sequentially in the opposite order to the order in which data has been written, the read control unit **114** can read data having a high degree of importance before the data is overwritten and erased in the ring buffer **111**. Therefore, even when the reading speed is lower than the writing speed, the read control unit **114** can read data having a high degree of importance stored in the ring buffer **111** and then store the data to the non-volatile memory **112** before the data is overwritten. Note that if the start timing is when the abnormality detection unit **115** detects an abnormality, data stored in the ring buffer **111** is highly related to the abnormality, i.e., has a high degree of importance. As a result, information which will help to maintain the multifunction peripheral **1** remains without being erased, which makes it easier to maintain the multifunction peripheral **1**.

The multifunction peripheral **1** also includes the ring buffer **111** having a plurality of storage areas corresponding to a plurality of addresses, and executes the storage control program **71**. The storage control program **71** is executed to perform the following information process. Specifically, the write process is performed in the first order, and after the beginning of execution of the write process, the read process is performed in the second order opposite to the first order, starting with an address at which data has been written by the write control unit **113** immediately before. Data stored in a storage area corresponding to an address at which the read process has begun and data stored in a storage area corresponding to the previous address preceding that address have

a high degree of importance. Therefore, if the read process is performed from the address at which data has been written by the write control unit **113** immediately before, sequentially in the opposite order to the order in which data has been written, the read control unit **114** can read data having a high degree of importance before the data is overwritten and erased in the ring buffer **111**. Thus, the storage control program **71** can be provided in which even when the reading speed is lower than the writing speed, the read control unit **114** can read data having a high degree of importance stored in the ring buffer **111** and then store the data to the non-volatile memory **112** before the data is overwritten. The storage medium **72** in which the storage control program **71** is stored can also be provided.

A storage control method is also provided which is performed by the storage control device **10** including the ring buffer **111** having a plurality of storage areas corresponding to a plurality of addresses. In the method, the write process is performed in the first order, and after the beginning of execution of the write process, the read process is performed in the second order opposite to the first order, starting with an address at which data has been written by the write control unit **113** immediately before. Data stored in a storage area corresponding to an address at which the read process has begun and data stored in a storage area corresponding to the previous address preceding that address have a high degree of importance. Therefore, if the read process is performed from the address at which data has been written by the write control unit **113** immediately before, sequentially in the opposite order to the order in which data has been written, the read control unit **114** can read data having a high degree of importance before the data is overwritten and erased in the ring buffer **111**. Thus, the storage control method can be provided in which even when the reading speed is lower than the writing speed, the read control unit **114** can read data having a high degree of importance, that is stored in the ring buffer **111**, and then store the data to the non-volatile memory **112** before the data is overwritten.

While embodiments of the present disclosure have been clearly and fully described with reference to the drawings, various modifications and improvements can be made by those skilled in the art without departing from the spirit and scope of the present disclosure. Therefore, such modifications and improvements are intended to be embraced in the present disclosure.

The invention claimed is:

1. A storage control device comprising:

a first storage unit including a plurality of storage areas corresponding to a plurality of addresses;

a write control unit configured to perform a write process to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged; and

a read control unit configured to perform a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing, wherein,

the write control unit designates the leading one of the plurality of addresses in the predetermined first order as an address to be next designated when, in the write process, data is stored to one of the plurality of storage areas corresponding to the trailing one of the plurality of addresses in the predetermined first order, and

the read control unit designates the leading one of the plurality of addresses in the second order as an address to be next designated when, in the read process, data is read from one of the plurality of storage areas corresponding to the trailing one of the plurality of addresses in the second order.

2. A storage control device of claim **1**, wherein

data in the plurality of storage areas of the first storage unit is allowed to be overwritten.

3. A storage control device of claim **1**, further comprising:

a non-volatile second storage unit,

wherein

the read control unit stores data read in the read process to the second storage unit.

4. An electronic apparatus comprising:

the storage control device of claim **1**; and

an operation unit configured to perform an operation,

wherein

data stored in the plurality of storage areas of the first storage unit is operation data related to the operation of the operation unit, and

in the write process, the write control unit sequentially stores the operation data to the first storage unit in time series, to store history information about the operation of the operation unit to the first storage unit.

5. An electronic apparatus of claim **4**, further comprising:

an abnormality detection unit configured to detect an abnormality in the operation unit, wherein

the predetermined start timing is when the abnormality detection unit detects the abnormality.

6. An electronic apparatus of claim **4**, wherein

the operation of the operation unit is formation of an image on paper.

7. A non-transitory computer readable storage medium having stored thereon a storage control program that, when executed by a computer including a first storage unit having a plurality of storage areas corresponding to a plurality of addresses, causes the computer to perform an information process,

wherein

the information process comprises:

performing a write process to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged; and

performing a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the predetermined first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing, wherein

in performing a write process, the leading one of the plurality of addresses in the predetermined first order

is designated as an address to be next designated when data is stored to one of the plurality of storage areas corresponding to the trailing one of the plurality of addresses in the predetermined first order; and

in performing a read process, the leading one of the plurality of addresses in the second order is designated as an address to be next designated when data is read from one of the plurality of storage areas corresponding to the trailing one of the plurality of addresses in the second order.

8. A storage control method performed by a storage control device including a first storage unit having a plurality of storage areas corresponding to a plurality of addresses, comprising:

performing a write process to sequentially designate one of the plurality of addresses and write data to one of the plurality of storage areas corresponding to the designated address, in a predetermined first order in which the plurality of addresses are arranged; and

performing a read process to sequentially designate one of the plurality of addresses and read data stored in one of the plurality of storage areas corresponding to the designated address, in a second order opposite to the predetermined first order, starting with one of the plurality of addresses corresponding to one of the plurality of storage areas in which data has been stored immediately near a predetermined start timing after the beginning of execution of the write process, the read process being started at the predetermined start timing, wherein

in performing a write process, the leading one of the plurality of addresses in the predetermined first order is designated as an address to be next designated when data is stored to one of the plurality of storage areas corresponding to the trailing one of the plurality of addresses in the predetermined first order, and

in performing a read process, the leading one of the plurality of addresses in the second order is designated as an address to be next designated when data is read from one of the plurality of storage areas corresponding to the trailing one of the plurality of addresses in the second order.

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